

# Enhanced Delta Smelt Monitoring

## 2021 Phase 3 Sampling

### Preliminary Analysis

**DRAFT**

U.S. Fish and Wildlife Service

October 22, 2021

## Overview

On June 28, 2021, the Enhanced Delta Smelt Monitoring (EDSM) program started 2021 Phase 3 sampling program for juvenile and sub-adult Delta Smelt. In order to improve our ability to make inferences about the population, sampling effort is being focused on eight geographic areas where Delta Smelt are likely to be caught based on historical data. Sampling locations are generated using a generalized random-tessellation stratified (GRTS) design [Stevens and Olsen, 2004] with stratification and equal probability sampling. Trawling gear similar to that used in the California Department of Fish and Wildlife's [Spring Kodiak Trawl Survey](#) is used to conduct multiple tows per location.

Everything presented here is preliminary and subject to correction, revision, and improvement. The following points should be taken into consideration when interpreting the results:

1. Delta Smelt captured outside of the live box or cod end of the net could not be assigned to a specific tow and were excluded from this analysis. These fish are included in the daily catch summary and are indicated by a Gear Condition Code of 9. Delta Smelt captured in highly impaired samples, e.g., samples with large net blockages of debris or vegetation, were also excluded from this analysis. These fish are included in the daily catch summary and are indicated by a Gear Condition Code of 3.
2. The **Week** designations used here were defined out of convenience and are subject to change.
3. Current sampling is limited to areas of the Bay-Delta that can be safely navigated by EDSM vessels, which means areas with a minimum depth of approximately 8 feet. The abundance estimation method used here assumes that the density of fish in unsampled areas (i.e., those with depth less than 8 feet) is the same as in sampled areas (i.e., those with depth greater than or equal to 8 feet).
4. The methods of analysis used here remain in development.

## Results

Table 1: Delta Smelt catch summary and abundance estimates by week. An asterisk (\*) is used to emphasize weeks when no Delta Smelt were caught and a dash (-) is used to indicate that sampling did not occur or that a quantity could not be calculated. In order to avoid confusion, weekly totals are only calculated when sampling has occurred in every stratum. Sample volumes are in cubic meters.

	Stratum	Number of Sites	Number of Tows	Number Caught	Total Sample Volume	Estimate and 95% CI		
						Abundance	Lower Bound	Upper Bound
Week 1: June 28 - July 1, 2021								
	Suisun Bay	6	22	0	95,360	0*	-	-
	Suisun Marsh	6	23	0	104,651	0*	-	-
	Lower Sacramento	6	24	0	96,389	0*	-	-
	Cache Slough LI	6	24	0	97,124	0*	-	-
	Sac DW Ship Channel	6	24	0	97,760	0*	-	-
	Lower San Joaquin	6	22	0	87,752	0*	-	-
	Total	36	139	0	579,035	0*	-	-
Week 2: July 6 - 9, 2021								
	Suisun Bay	6	24	0	113,618	0*	-	-
	Suisun Marsh	6	22	0	99,286	0*	-	-
	Lower Sacramento	6	24	0	101,528	0*	-	-
	Cache Slough LI	6	24	0	83,216	0*	-	-
	Sac DW Ship Channel	6	22	0	81,096	0*	-	-
	Lower San Joaquin	6	24	0	95,989	0*	-	-
	Total	36	140	0	574,734	0*	-	-
Week 3: July 12 - 15, 2021								
	Suisun Bay	5	20	0	92,392	0*	-	-
	Suisun Marsh	6	24	0	107,773	0*	-	-
	Lower Sacramento	6	24	0	107,644	0*	-	-
	Cache Slough LI	6	24	0	83,423	0*	-	-
	Sac DW Ship Channel	6	22	0	82,293	0*	-	-
	Lower San Joaquin	6	24	0	103,373	0*	-	-
	Total	35	138	0	576,897	0*	-	-
Week 4: July 19 - 22, 2021								
	Suisun Bay	6	24	0	115,008	0*	-	-
	Suisun Marsh	6	24	0	91,799	0*	-	-
	Lower Sacramento	6	24	0	109,336	0*	-	-
	Cache Slough LI	6	21	0	74,791	0*	-	-
	Sac DW Ship Channel	6	24	0	73,566	0*	-	-
	Lower San Joaquin	6	24	0	102,468	0*	-	-
	Total	36	141	0	566,968	0*	-	-
Week 5: July 26 - 29, 2021								
	Suisun Bay	3	12	0	61,616	0*	-	-
	Suisun Marsh	6	24	0	102,621	0*	-	-
	Lower Sacramento	6	24	0	106,677	0*	-	-
	Cache Slough LI	6	24	0	88,898	0*	-	-
	Sac DW Ship Channel	6	24	0	91,731	0*	-	-

Table 1: Delta Smelt catch summary and abundance estimates by week. An asterisk (\*) is used to emphasize weeks when no Delta Smelt were caught and a dash (-) is used to indicate that sampling did not occur or that a quantity could not be calculated. In order to avoid confusion, weekly totals are only calculated when sampling has occurred in every stratum. Sample volumes are in cubic meters.

Stratum	Number of Sites	Number of Tows	Number Caught	Total Sample Volume	Estimate and 95% CI		
					Abundance	Lower Bound	Upper Bound
Lower San Joaquin	6	24	0	112,341	0*	-	-
Total	33	132	0	563,885	0*	-	-
<b>Week 6: August 2 - 6, 2021</b>							
Suisun Bay	5	16	0	71,091	0*	-	-
Suisun Marsh	3	8	0	34,010	0*	-	-
Lower Sacramento	6	22	0	89,827	0*	-	-
Cache Slough LI	6	24	0	72,187	0*	-	-
Sac DW Ship Channel	6	24	0	82,829	0*	-	-
Lower San Joaquin	5	20	0	78,444	0*	-	-
Total	31	114	0	428,388	0*	-	-
<b>Week 7: August 9 - 12, 2021</b>							
Suisun Bay	0	-	-	-	-	-	-
Suisun Marsh	6	24	0	86,504	0*	-	-
Lower Sacramento	5	18	0	77,458	0*	-	-
Cache Slough LI	6	24	0	81,633	0*	-	-
Sac DW Ship Channel	6	24	0	80,764	0*	-	-
Lower San Joaquin	6	24	0	117,382	0*	-	-
Total	29	114	0	443,741	-	-	-
<b>Week 8: August 16 - 20, 2021</b>							
Suisun Bay	6	24	0	91,592	0*	-	-
Suisun Marsh	6	24	0	96,829	0*	-	-
Lower Sacramento	6	24	0	105,556	0*	-	-
Cache Slough LI	5	20	0	66,130	0*	-	-
Sac DW Ship Channel	4	8	1	28,954	1,455	201	5,260
Lower San Joaquin	0	-	-	-	-	-	-
Total	27	100	1	389,060	-	-	-
<b>Week 9: August 23 - 26, 2021</b>							
Suisun Bay	6	24	0	115,838	0*	-	-
Suisun Marsh	6	22	0	94,741	0*	-	-
Lower Sacramento	6	24	0	114,861	0*	-	-
Cache Slough LI	6	24	0	82,363	0*	-	-
Sac DW Ship Channel	6	24	0	89,702	0*	-	-
Lower San Joaquin	6	22	0	105,923	0*	-	-
Total	36	140	0	603,428	0*	-	-
<b>Week 10: August 30 - September 2, 2021</b>							
Suisun Bay	5	18	0	75,745	0*	-	-
Suisun Marsh	5	20	0	79,864	0*	-	-
Lower Sacramento	6	24	0	94,820	0*	-	-
Cache Slough LI	6	22	0	84,642	0*	-	-

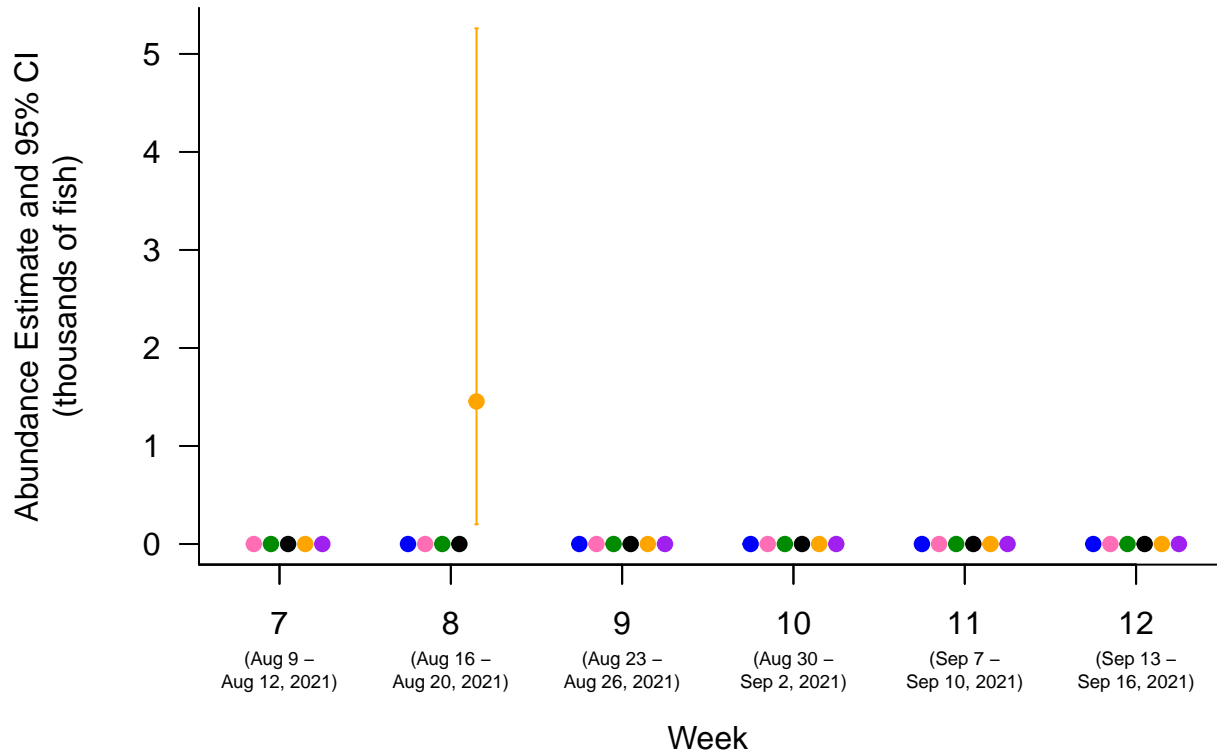
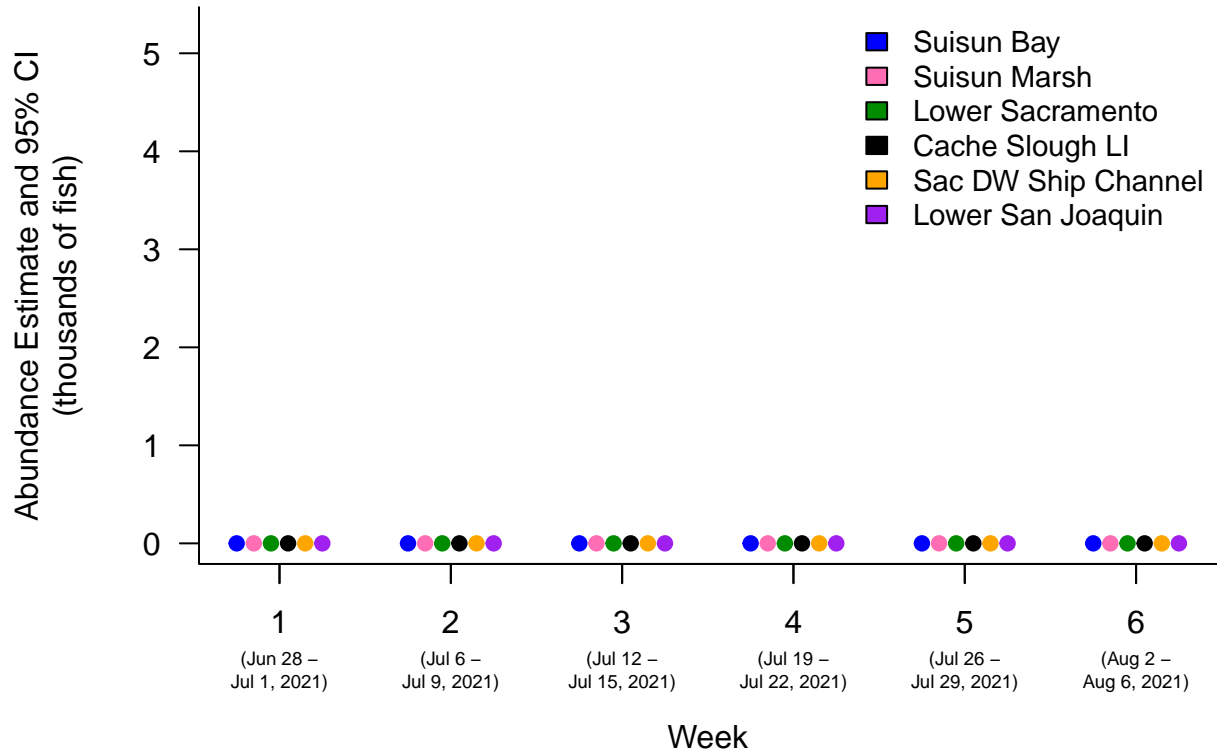
Table 1: Delta Smelt catch summary and abundance estimates by week. An asterisk (\*) is used to emphasize weeks when no Delta Smelt were caught and a dash (-) is used to indicate that sampling did not occur or that a quantity could not be calculated. In order to avoid confusion, weekly totals are only calculated when sampling has occurred in every stratum. Sample volumes are in cubic meters.

Stratum	Number of Sites	Number of Tows	Number Caught	Total Sample Volume	Estimate and 95% CI		
					Abundance	Lower Bound	Upper Bound
Sac DW Ship Channel	6	24	0	98,133	0*	-	-
Lower San Joaquin	6	22	0	86,810	0*	-	-
Total	34	130	0	520,013	0*	-	-
<b>Week 11: September 7 - 10, 2021</b>							
Suisun Bay	6	24	0	101,710	0*	-	-
Suisun Marsh	6	24	0	96,608	0*	-	-
Lower Sacramento	6	24	0	90,930	0*	-	-
Cache Slough LI	6	24	0	83,388	0*	-	-
Sac DW Ship Channel	2	8	0	34,085	0*	-	-
Lower San Joaquin	6	24	0	90,686	0*	-	-
Total	32	128	0	497,407	0*	-	-
<b>Week 12: September 13 - 16, 2021</b>							
Suisun Bay	6	24	0	111,272	0*	-	-
Suisun Marsh	6	22	0	102,781	0*	-	-
Lower Sacramento	6	24	0	96,520	0*	-	-
Cache Slough LI	6	24	0	80,901	0*	-	-
Sac DW Ship Channel	6	24	0	79,889	0*	-	-
Lower San Joaquin	6	24	0	110,102	0*	-	-
Total	36	142	0	581,465	0*	-	-
<b>Week 13: September 20 - 23, 2021</b>							
Suisun Bay	6	24	0	108,810	0*	-	-
Suisun Marsh	6	23	0	88,132	0*	-	-
Lower Sacramento	6	24	0	113,342	0*	-	-
Cache Slough LI	6	22	0	69,813	0*	-	-
Sac DW Ship Channel	6	24	0	79,715	0*	-	-
Lower San Joaquin	6	24	0	118,225	0*	-	-
Total	36	141	0	578,038	0*	-	-
<b>Week 14: September 27 - 30, 2021</b>							
Suisun Bay	6	24	0	96,170	0*	-	-
Suisun Marsh	6	24	0	88,141	0*	-	-
Lower Sacramento	5	20	0	85,479	0*	-	-
Cache Slough LI	6	24	0	82,380	0*	-	-
Sac DW Ship Channel	6	24	0	93,007	0*	-	-
Lower San Joaquin	6	24	0	96,708	0*	-	-
Total	35	140	0	541,885	0*	-	-
<b>Week 15: October 4 - 7, 2021</b>							
Suisun Bay	6	24	0	104,320	0*	-	-
Suisun Marsh	6	24	0	98,651	0*	-	-
Lower Sacramento	6	24	0	99,151	0*	-	-

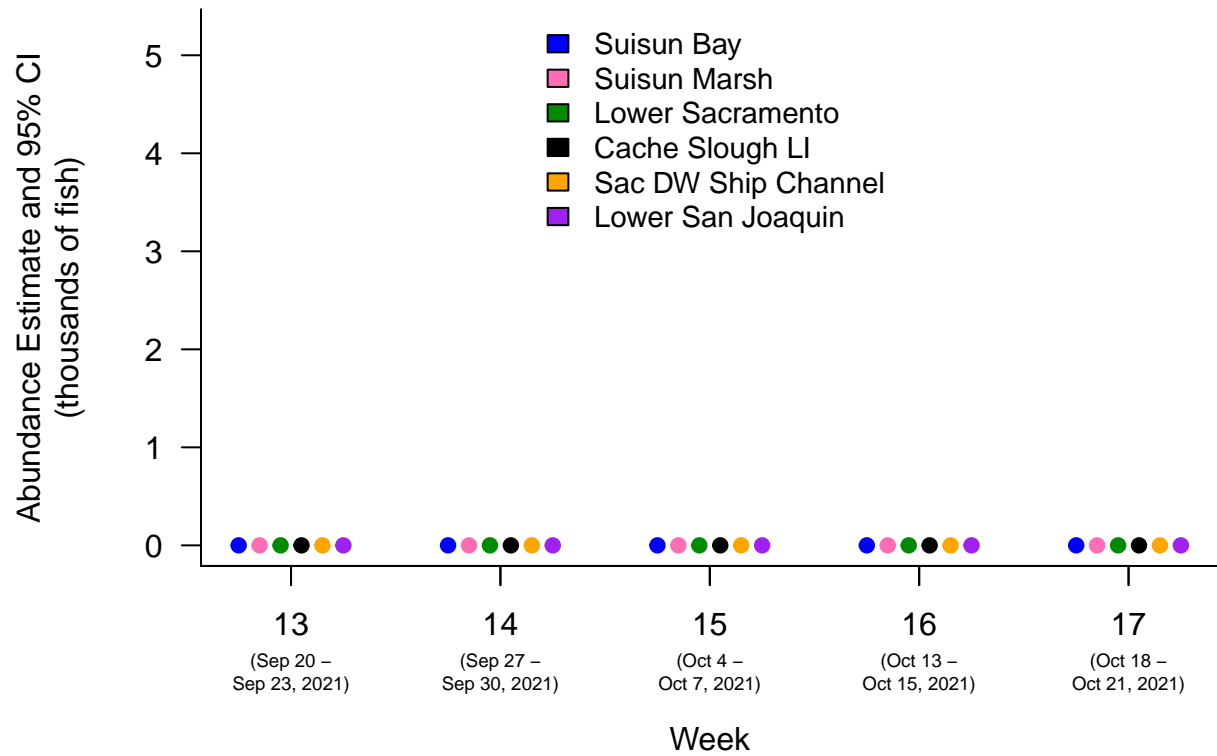
Table 1: Delta Smelt catch summary and abundance estimates by week. An asterisk (\*) is used to emphasize weeks when no Delta Smelt were caught and a dash (-) is used to indicate that sampling did not occur or that a quantity could not be calculated. In order to avoid confusion, weekly totals are only calculated when sampling has occurred in every stratum. Sample volumes are in cubic meters.

Stratum	Number of Sites	Number of Tows	Number Caught	Total Sample Volume	Estimate and 95% CI		
					Abundance	Lower Bound	Upper Bound
Cache Slough LI	6	22	0	87,326	0*	-	-
Sac DW Ship Channel	6	24	0	91,019	0*	-	-
Lower San Joaquin	6	24	0	89,914	0*	-	-
Total	36	142	0	570,380	0*	-	-
<b>Week 16: October 13 - 15, 2021</b>							
Suisun Bay	3	12	0	62,448	0*	-	-
Suisun Marsh	3	12	0	50,074	0*	-	-
Lower Sacramento	3	12	0	50,965	0*	-	-
Cache Slough LI	3	12	0	45,642	0*	-	-
Sac DW Ship Channel	6	24	0	93,753	0*	-	-
Lower San Joaquin	6	24	0	93,664	0*	-	-
Total	24	96	0	396,546	0*	-	-
<b>Week 17: October 18 - 21, 2021</b>							
Suisun Bay	6	24	0	130,148	0*	-	-
Suisun Marsh	6	24	0	115,861	0*	-	-
Lower Sacramento	6	24	0	99,132	0*	-	-
Cache Slough LI	6	24	0	84,674	0*	-	-
Sac DW Ship Channel	6	24	0	87,716	0*	-	-
Lower San Joaquin	6	23	0	94,810	0*	-	-
Total	36	143	0	612,341	0*	-	-

## Delta Smelt Abundance Estimates Over Time



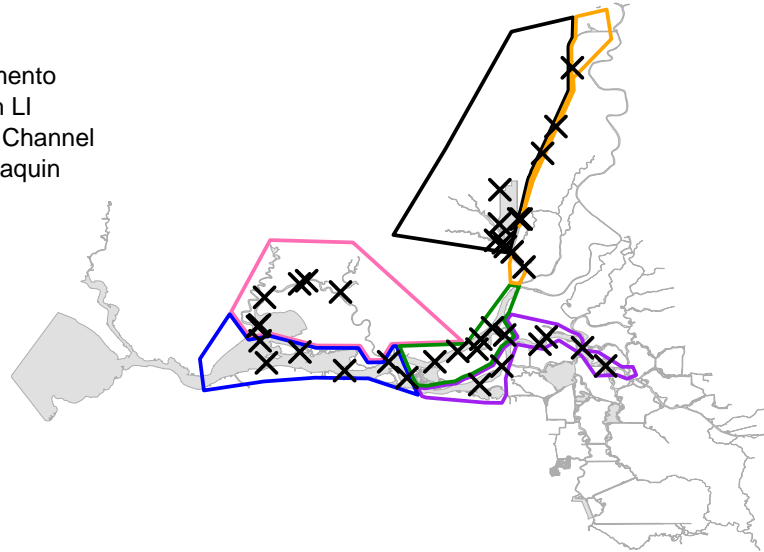
## Delta Smelt Abundance Estimates Over Time



## Week 1 (June 28 – July 1, 2021)

### Delta Smelt Total Catch by Site

- Suisun Bay
- Suisun Marsh
- Lower Sacramento
- Cache Slough LI
- Sac DW Ship Channel
- Lower San Joaquin



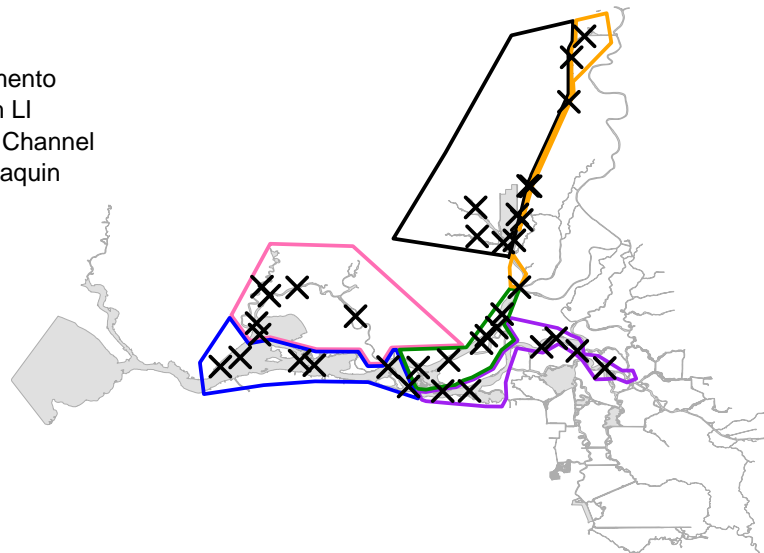
Total Catch

X 0

## Week 2 (July 6 – 9, 2021)

### Delta Smelt Total Catch by Site

- Suisun Bay
- Suisun Marsh
- Lower Sacramento
- Cache Slough LI
- Sac DW Ship Channel
- Lower San Joaquin



Total Catch

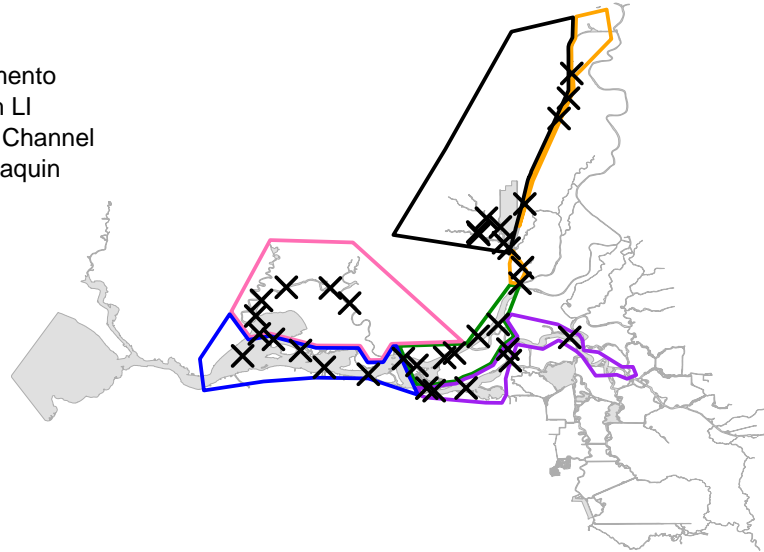
X 0



### Week 3 (July 12 – 15, 2021)

#### Delta Smelt Total Catch by Site

- Suisun Bay
- Suisun Marsh
- Lower Sacramento
- Cache Slough LI
- Sac DW Ship Channel
- Lower San Joaquin



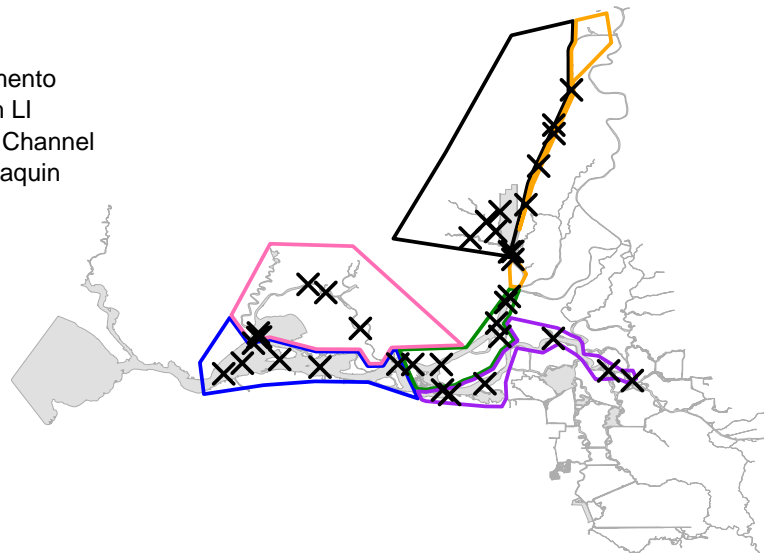
Total Catch

X 0

### Week 4 (July 19 – 22, 2021)

#### Delta Smelt Total Catch by Site

- Suisun Bay
- Suisun Marsh
- Lower Sacramento
- Cache Slough LI
- Sac DW Ship Channel
- Lower San Joaquin



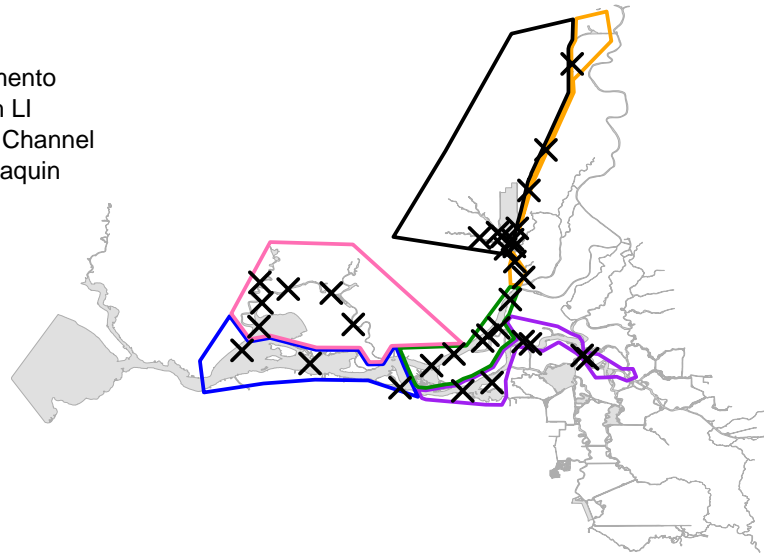
Total Catch

X 0

## Week 5 (July 26 – 29, 2021)

### Delta Smelt Total Catch by Site

- Suisun Bay
- Suisun Marsh
- Lower Sacramento
- Cache Slough LI
- Sac DW Ship Channel
- Lower San Joaquin



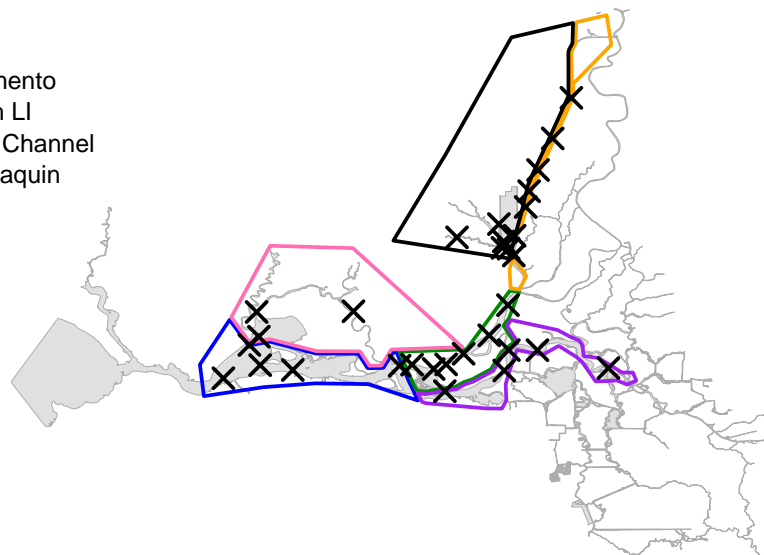
Total Catch

X 0

## Week 6 (August 2 – 6, 2021)

### Delta Smelt Total Catch by Site

- Suisun Bay
- Suisun Marsh
- Lower Sacramento
- Cache Slough LI
- Sac DW Ship Channel
- Lower San Joaquin



Total Catch

X 0

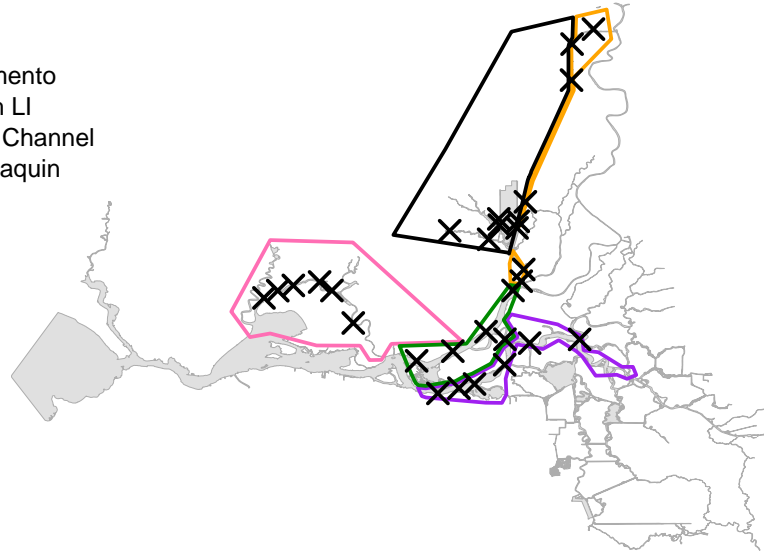
## Week 7 (August 9 – 12, 2021)

### Delta Smelt Total Catch by Site

- Suisun Bay
- Suisun Marsh
- Lower Sacramento
- Cache Slough LI
- Sac DW Ship Channel
- Lower San Joaquin

Total Catch

× 0



## Week 8 (August 16 – 20, 2021)

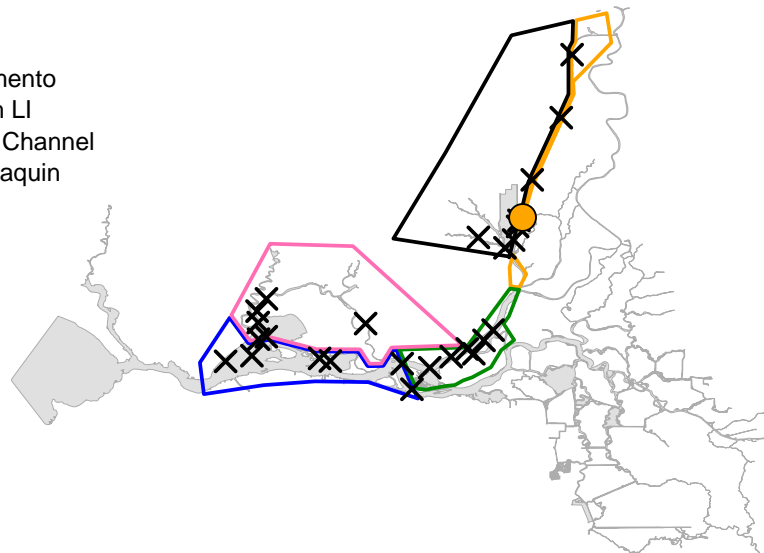
### Delta Smelt Total Catch by Site

- Suisun Bay
- Suisun Marsh
- Lower Sacramento
- Cache Slough LI
- Sac DW Ship Channel
- Lower San Joaquin

Total Catch

× 0

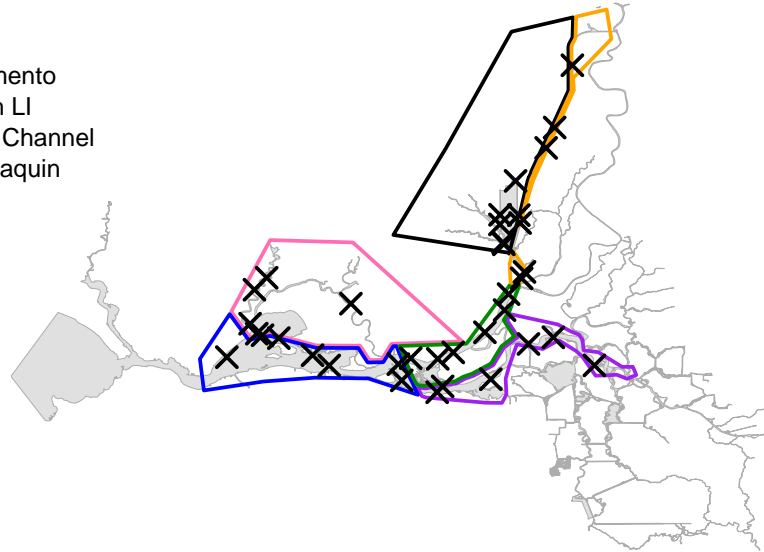
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## Week 9 (August 23 – 26, 2021)

### Delta Smelt Total Catch by Site

- Suisun Bay
- Suisun Marsh
- Lower Sacramento
- Cache Slough LI
- Sac DW Ship Channel
- Lower San Joaquin



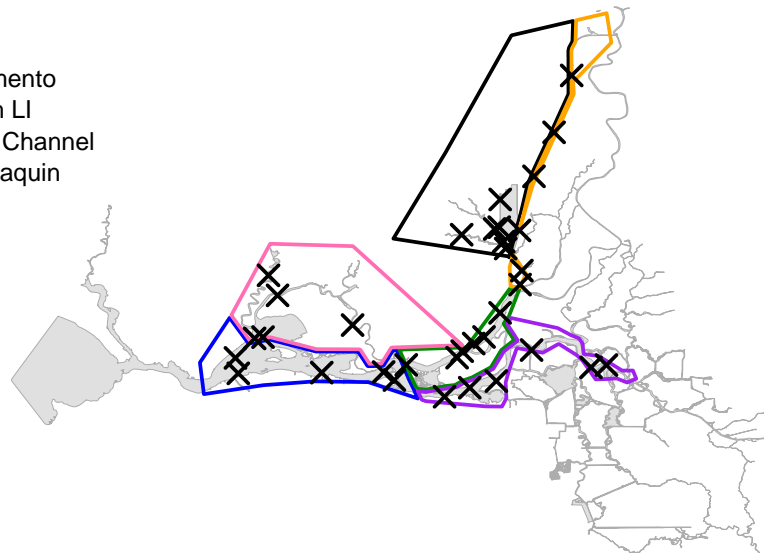
Total Catch

X 0

## Week 10 (August 30 – September 2, 2021)

### Delta Smelt Total Catch by Site

- Suisun Bay
- Suisun Marsh
- Lower Sacramento
- Cache Slough LI
- Sac DW Ship Channel
- Lower San Joaquin



Total Catch

X 0

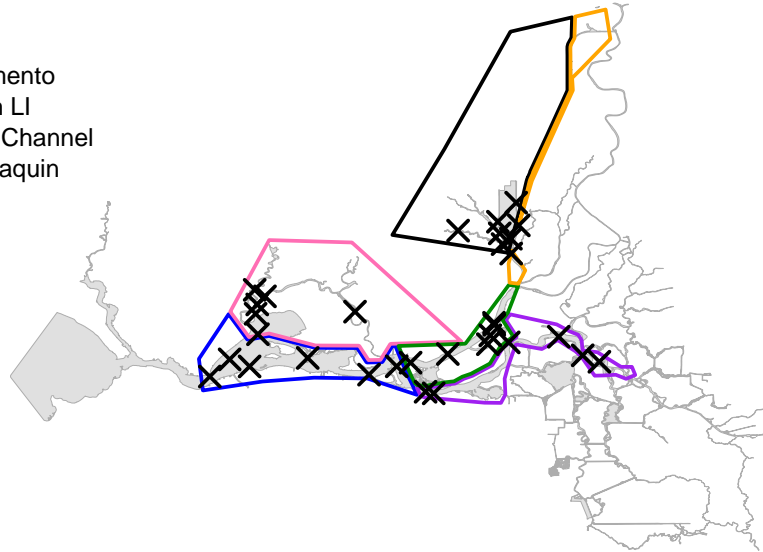
## Week 11 (September 7 – 10, 2021)

### Delta Smelt Total Catch by Site

- Suisun Bay
- Suisun Marsh
- Lower Sacramento
- Cache Slough LI
- Sac DW Ship Channel
- Lower San Joaquin

Total Catch

X 0



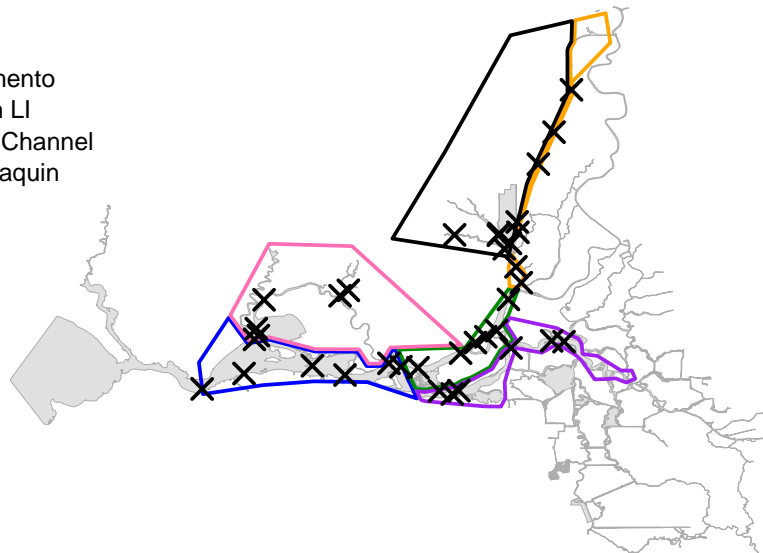
## Week 12 (September 13 – 16, 2021)

### Delta Smelt Total Catch by Site

- Suisun Bay
- Suisun Marsh
- Lower Sacramento
- Cache Slough LI
- Sac DW Ship Channel
- Lower San Joaquin

Total Catch

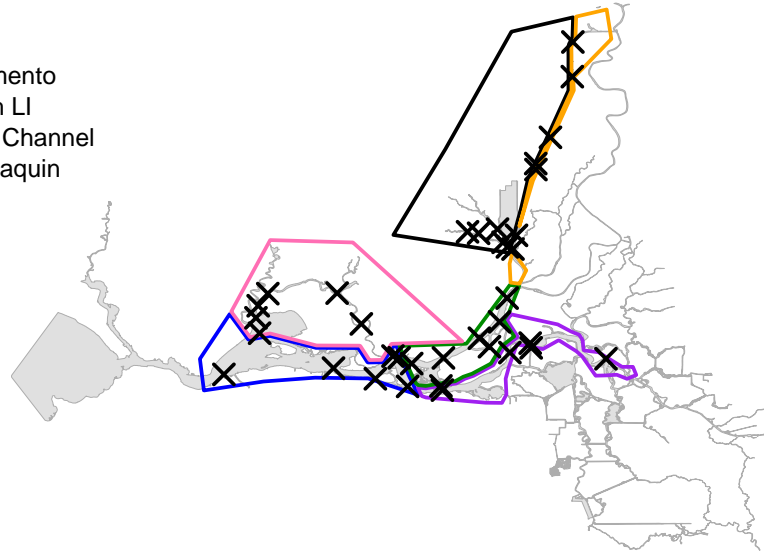
X 0



## Week 13 (September 20 – 23, 2021)

### Delta Smelt Total Catch by Site

- Suisun Bay
- Suisun Marsh
- Lower Sacramento
- Cache Slough LI
- Sac DW Ship Channel
- Lower San Joaquin



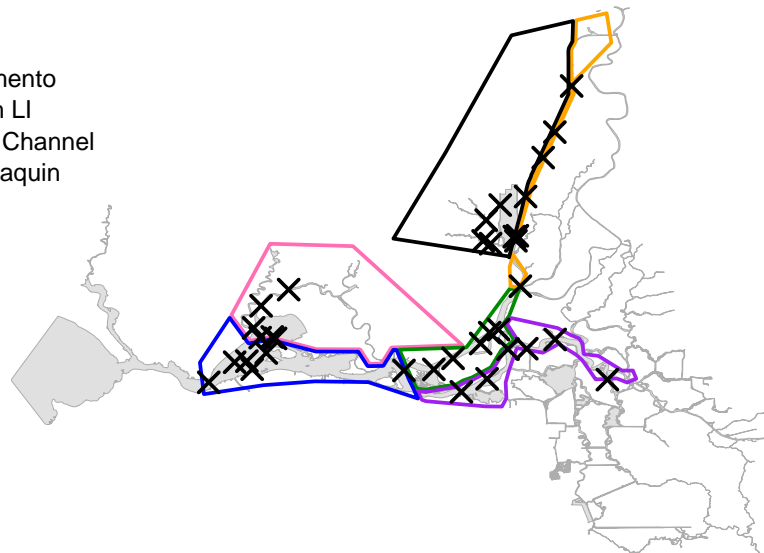
Total Catch

× 0

## Week 14 (September 27 – 30, 2021)

### Delta Smelt Total Catch by Site

- Suisun Bay
- Suisun Marsh
- Lower Sacramento
- Cache Slough LI
- Sac DW Ship Channel
- Lower San Joaquin



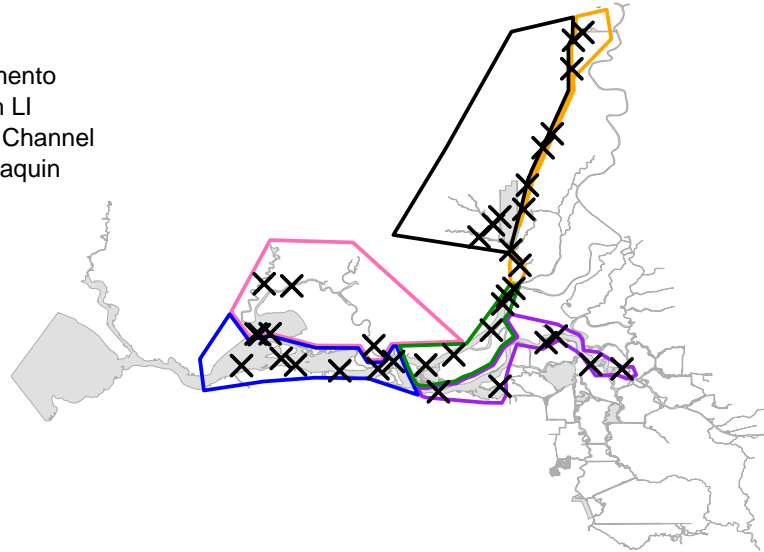
Total Catch

× 0

## Week 15 (October 4 – 7, 2021)

### Delta Smelt Total Catch by Site

- Suisun Bay
- Suisun Marsh
- Lower Sacramento
- Cache Slough LI
- Sac DW Ship Channel
- Lower San Joaquin



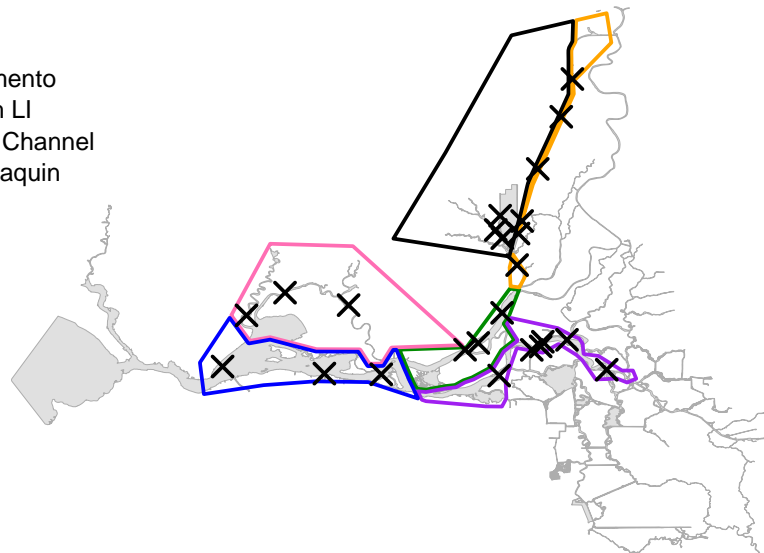
Total Catch

X 0

## Week 16 (October 13 – 15, 2021)

### Delta Smelt Total Catch by Site

- Suisun Bay
- Suisun Marsh
- Lower Sacramento
- Cache Slough LI
- Sac DW Ship Channel
- Lower San Joaquin



Total Catch

X 0

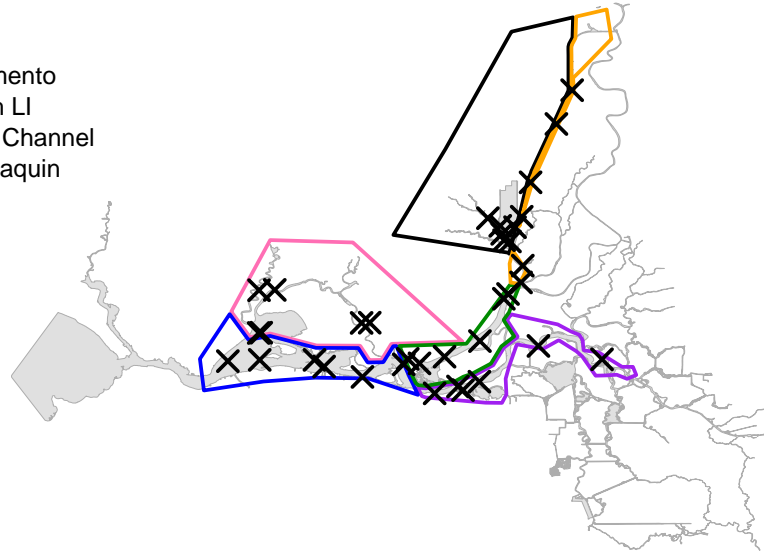
## Week 17 (October 18 – 21, 2021)

### Delta Smelt Total Catch by Site

- Suisun Bay
- Suisun Marsh
- Lower Sacramento
- Cache Slough LI
- Sac DW Ship Channel
- Lower San Joaquin

Total Catch

× 0





## All Sampling Locations To Date

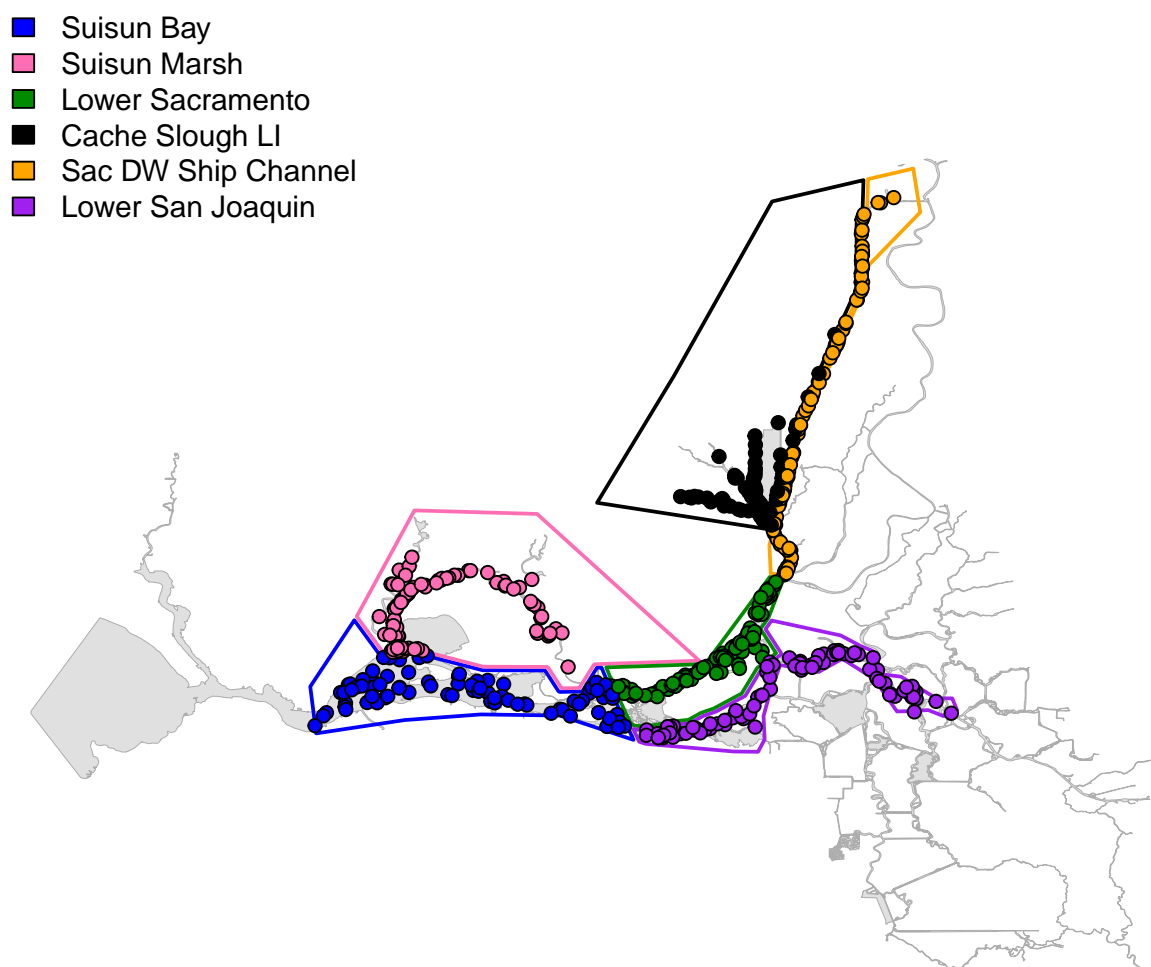


Table 2: Estimates of water volume (cubic meters) between 0.5-m and 4.5-m depth, by stratum.

Stratum	Volume
Cache Slough LI	33,420,492
Lower Sacramento	88,162,170
Lower San Joaquin	122,096,565
Sac DW Ship Channel	30,411,491
Suisun Bay	285,840,678
Suisun Marsh	76,278,718

## References

D. L. Stevens and A. R. Olsen. Spatially balanced sampling of natural resources. *Journal of the American Statistical Association*, 99(465):262 – 278, 2004.